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NASA Technical Memorandum 78647

AIRBORNE ANTENNA COVERAGE REQUIREMENTS FOR THE TCV B-737 AIRCRAFT

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REQUIREMENTS FOR THE TCV B-737 AIRCRAFT
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AIRBORNE ANTENNA COVERAGE REQUIREMENTS FOR THE TCV B-737 AIRCRAFT

Summary

A study was conducted to determine the airborne antenna line of sight look angle requirement for operation with a Microwave Landing System (MLS). This report presents the required azimuth and elevation line of sight look angles from an antenna located on an aircraft to three ground based antenna sites at the Wallops Flight Center (FPS-16 radar, MLS azimuth, and MLS elevation) as the aircraft follows specific approach paths selected as representative of MLS operations at the Denver, Colorado, terminal area. These required azimuth and elevation look angles may be interpreted as basic design requirements for antennae of the TCV B-737 airplane for MLS operations along these selected approach paths.

Introduction

Two areas of investigation included in the Terminal Configured Vehicle (TCV) program are Microwave Landing System (MLS) utilization and the Cockpit Display of Traffic Information (CDTI). The required facilities for these tasks, both airborne and ground based are located at Langley Research Center (LRC) and Wallops Flight Center (WFC). Landing guidance information will be transmitted to the aircraft from either an MLS (when available at WFC) or from a simulated MLS using the WFC FPS-16 Radar/Transponder Data System. For the CDTI case, an S-band video link has been implemented. The S-band transmit antenna is mounted on the FPS-16 pedestal. This report presents the azimuth and elevation look angles from the aircraft to the ground antenna sites for four flight profiles. The four terminal area flight profiles considered

are those proposed by the FAA for the Denver, Colorado, terminal area for MLS operation studies. The Denver terminal area is shown in figure 1 with the four paths labeled profile 1, 2, 3, 4.

Description of Computer Program

A computer program was written in Basic for a Hewlett-Packard 2116 computer. See appendix A for the program listing. The computer program input parameters are:

- 1- distance between waypoints
- 2- aircraft heading, airspeed, and altitude at each waypoint
- 3- aircraft bank angle limit
- 4- turn radius
- 5- MLS coverage boundary
- 6- number of points to be investigated along each flight path segment

The program output parameters are:

- 1- x (runway center line), y (perpendicular to runway centerline) and flat earth z (local vertical) coordinate values for n (number of) aircraft positions along each flight path segment (refer to figure 1)
- 2- azimuth (beta) and elevation (alpha) look angles from the aircraft to either of three ground antenna sites for each x, y, z position
- 3- azimuth and elevation look angles from each ground antenna to aircraft at each x, y, z position
- 4- glideslope required to achieve the next waypoint altitude
- 5- slant range between aircraft and each ground antenna site
- 6- transmission loss for each slant range of item 5
- 7- statement as to whether aircraft is or is not within MLS coverage zone
- 8- bank angle

- 9- aircraft groundspeed
- 10- distance to go to touchdown along the flight path
- 11- aircraft heading

The program performs any one of three operations as per the setting of three control words J4, J7, J8. Control word J4 sets the program for calculation and storage of the look angles to the MLS antenna sites and aircraft x, y position or calculation and storage of the look angles to the FPS-16 radar site. Control word J7 determines whether the program will store the flight path data or the look angles to the MLS. Control word J8 determines whether the program will print all data and store the look angles or only store. For the FPS-16 radar case, the operator must input the x, y (J5, J6) location of the radar relative to the touchdown point. For the MLS case, the azimuth antenna is sited 9,000 ft beyond the touchdown point on the runway centerline and the elevation antenna is sited adjacent to the touchdown point, 300 ft to the right of the runway centerline. The origin of the coordinate system is located at the touchdown point which is on the runway centerline 1,000 ft beyond threshold. Figure 2 gives the WFC runway and antenna geometry. Beginning at the outermost waypoint the aircraft proceeds to the next waypoint in n steps. This process continues from waypoint to waypoint until the first turn is reached. At this time the aircraft stops, assumes the designated bank angle in n steps, then continues around the turn in n steps. Upon completing the turn, the aircraft again stops and returns to wings level in n steps continuing on in a like manner to the touchdown point. The output parameters are computed at each of the n steps of each segment of the path.

Results

The results are presented in four data sets, one set for each of the four approach profiles investigated. In each case, the active runway at WFC is 04 as shown in the first figure of each set. Table 1 gives the parameters of each flight profile. The next three figures in each set are plots of the look angles. Negative azimuth angles are to the left of the aircraft longitudinal axis and negative elevation angles are below the aircraft lateral axis. For profile 1 (figure 3), the look angle to the MLS azimuth antenna (figure 3a) varied from 3° to -167° in azimuth and 25° to -36° in elevation. The look angle to the MLS E1-1 antenna (figure 3b) varied from 90° to -165° in azimuth and 24° to -36° in elevation. The look angle to the FPS-16 radar (figure 3c) varied from -1° to -167° in azimuth and 24° to -37° in elevation. For profile 2 (figure 4) the look angle to the MLS azimuth antenna (figure 4a) varied from 14° to -167° in azimuth and 24° to -31° in elevation. The look angle to the MLS E1-1 antenna (figure 4b) varied from 17° to -161° in azimuth and 24° to -28° in elevation. The look angle to the FPS-16 radar (figure 4c) varied from 17° to -167° in azimuth and 24° to -29° in elevation. Profiles 3 and 4 (figures 5, a, b, c, and 6 a, b, c) are very similar with the azimuth angle varying from -20° to 160° and the elevation angle varying from 25° to -35° . For the other WFC runways, the look angles to the MLS antenna are identical to those of 04 and only slightly different for the FPS-16 radar.

Concluding Remarks

The antenna coverage requirements based on four specific flight profiles have been determined. The antenna has been designed as per these requirements and found, due to hardware location constraints, to have considerably less

elevation coverage than the required -35° in the turn to the downwind leg.

It is recommended, therefore, that the design be implemented as is and adjustments be made to the flight profiles such that the turn to the downwind leg occurs outside of the MLS coverage zone. This change in the profile will not be detrimental to the planned research in MLS utilization or CDTI.

References

1. Mitre Corporation presentation at Langley Research Center. "Functional Description of a Ground Based Metering and Spacing System Using MLS."
2. Reeder, John P.; Taylor, Robert T.; and Walsh, Thomas M.: New Design and Operating Techniques and Requirements for Improved Aircraft Terminal Area Operations. NASA TMX-72006, December 1974.

Table 1

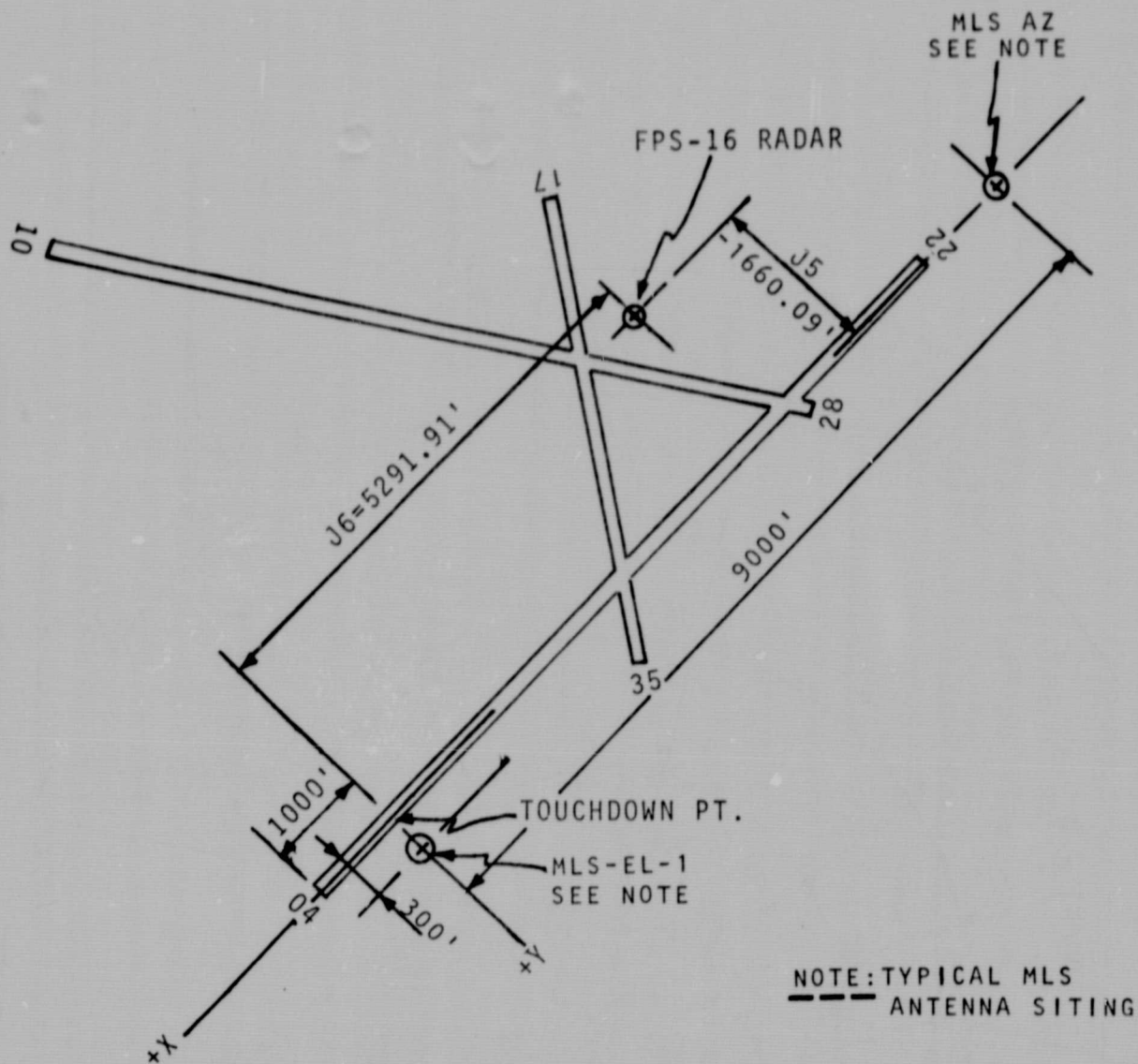
	<u>Profile 1</u>	<u>Profile 2</u>	<u>Profile 3</u>	<u>Profile 4</u>
H 1 degrees	40	40	40	40
H 2 degrees	40	40	40	40
H 3 degrees	130	130	310	310
H 4 degrees	220	220	220	220
H 5 degrees	133	182	263	309
S 1 nm	5	5	5	5
S 2 nm	7	7	7	7
S 3 nm	2	2	4	4
S 4 nm	6.5	19.5	7	7
S 5 nm	25	14	26	19
S 6 nm	16	23	18	19.5

Altitude ft/groundspeed knots

at PT 1	1750/130	1750/130	1750/130	1750/130
at PT 2	2750/160	2750/160	2750/160	2750/160
at PT 3	2750/160	2750/160	2750/160	2750/160
at PT 4	2750/180	2750/180	2750/180	2750/180
at PT 5	2750/180	2750/180	2750/180	2750/180
at PT 6	3750/200	6750/250	3750/200	3750/200
at PT 7	3750/200	6750/250	3750/200	3750/200
at PT 8	7750/250	8750/250	6750/250	6750/250
at PT 9	12750/350	12750/350	12750/350	12750/350

H is aircraft heading in degrees

S is length of flight path segment in nautical miles



NOTE: TYPICAL MLS
 --- ANTENNA SITING

RUNWAY	J5	J6
04	-1660.09	-5291.91
22	1660.09	-1455.56
28	465.08	-987.2
10	-465.08	-4994.23

LOCATION OF FPS-16 RADAR RELATIVE TO
 TOUCHDOWN POINT

WALLOPS FLIGHT CENTER

FIGURE 2

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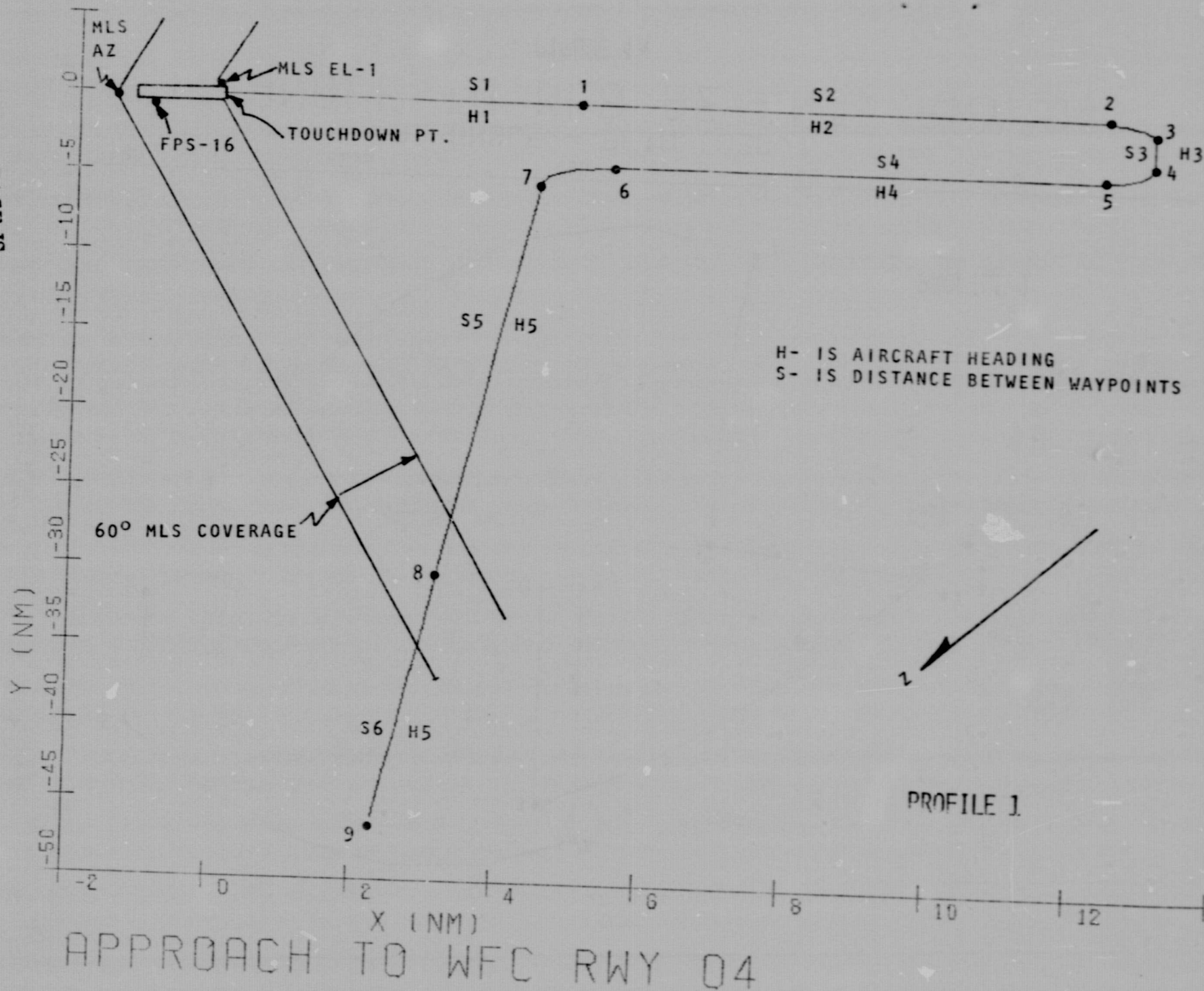
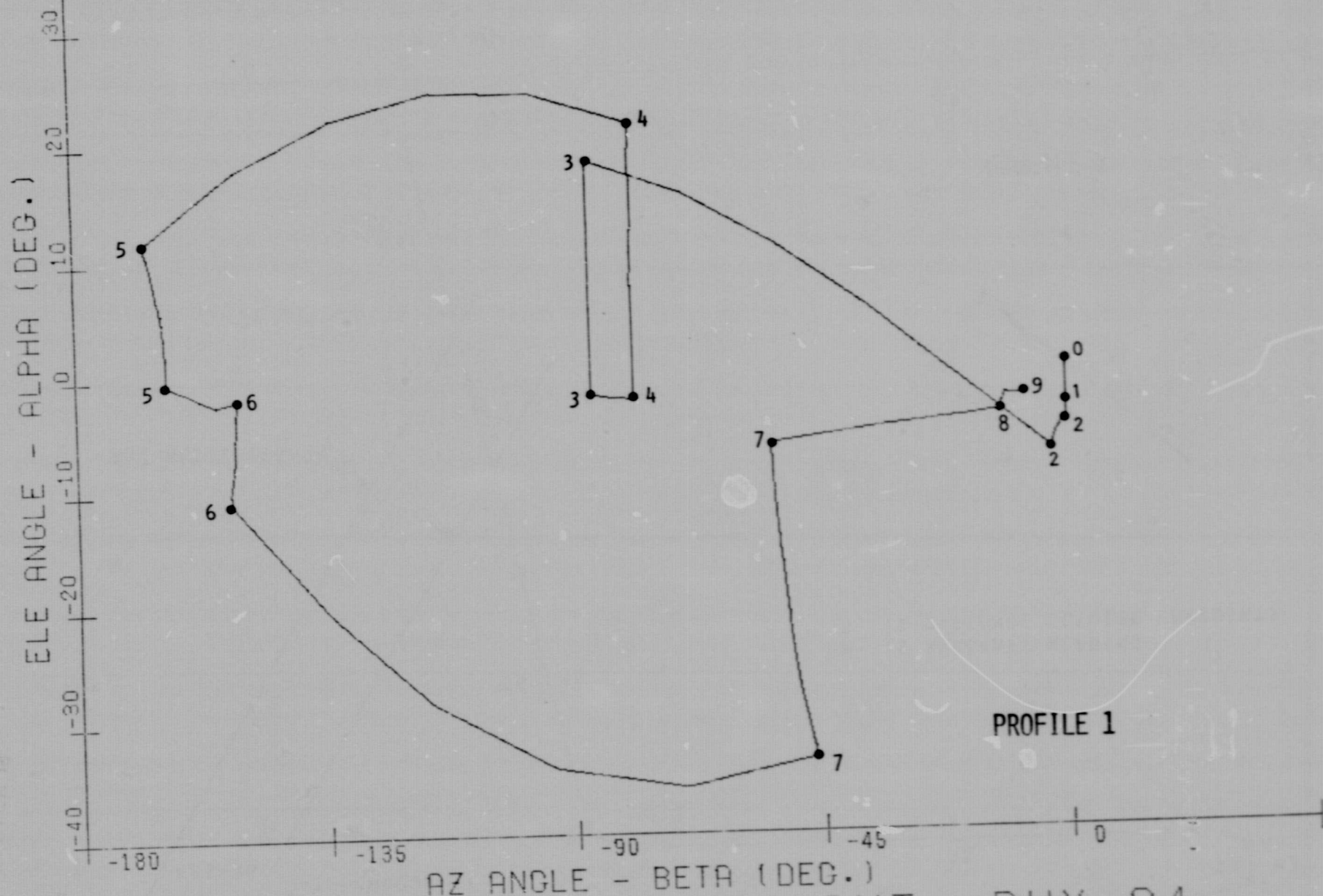
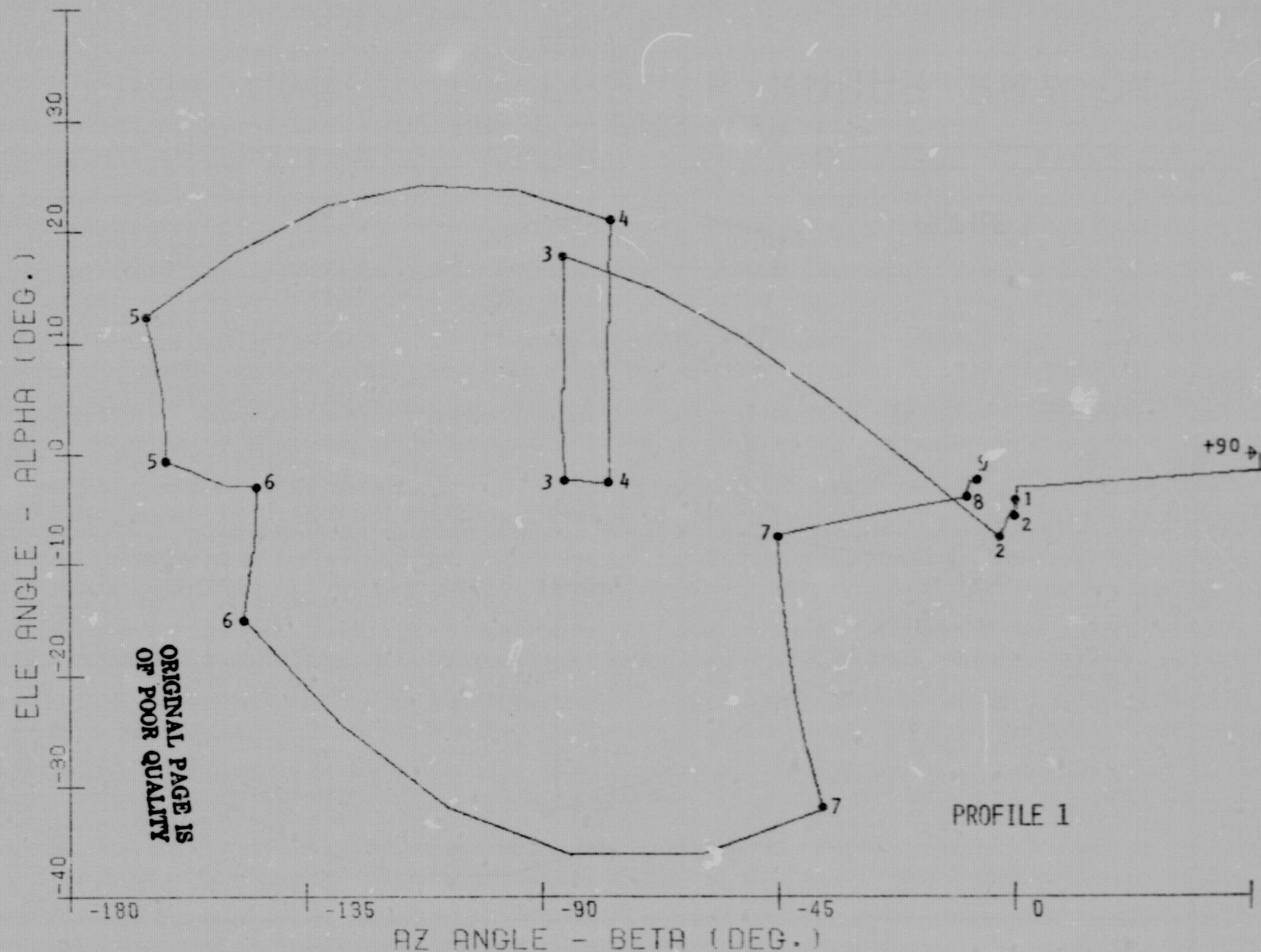


FIGURE 3



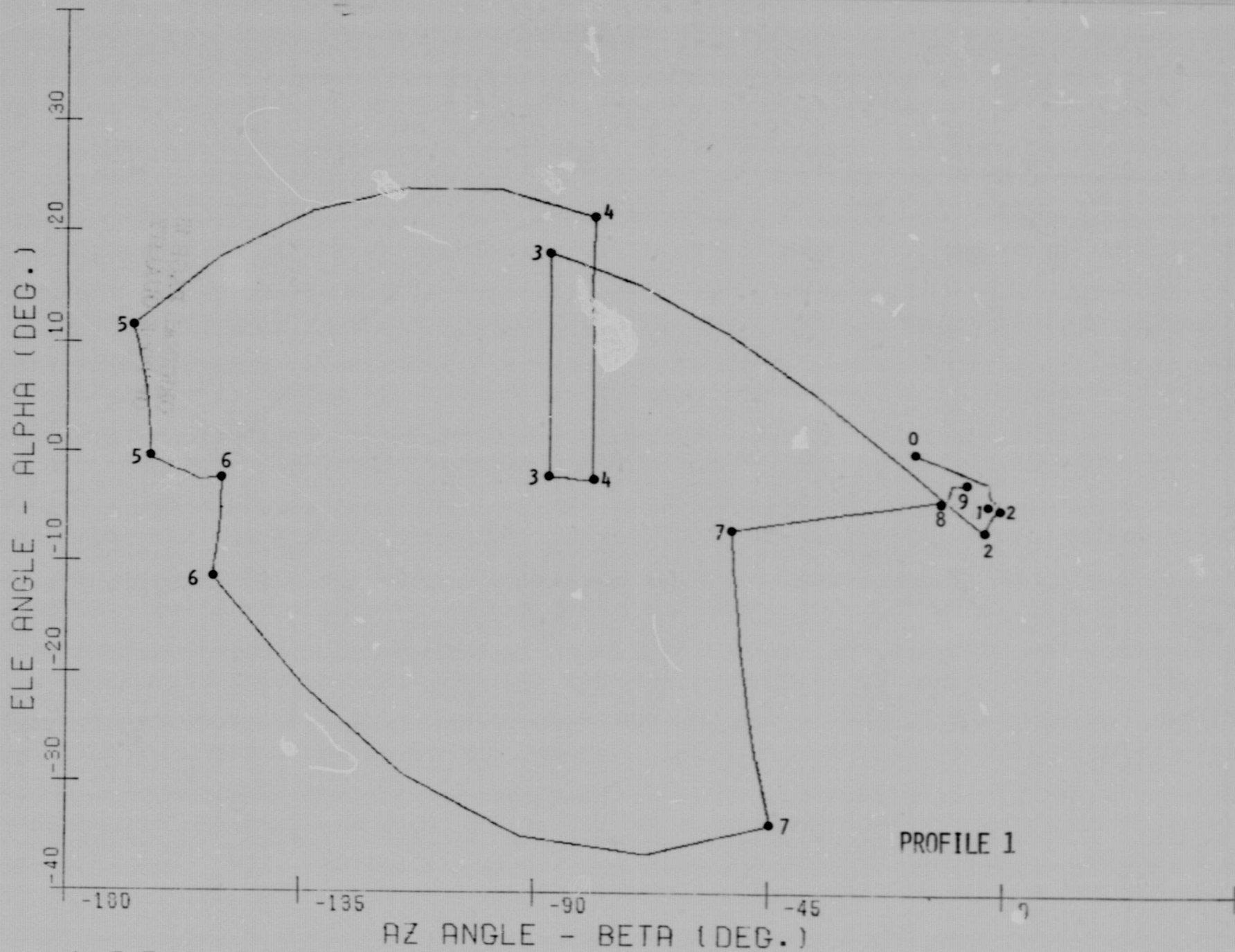
LOOK ANGLE TO MLS AZ ANT. RWY 04

FIGURE 3A



LOOK ANGLE TO MLS EL-1 ANT. RWY 04

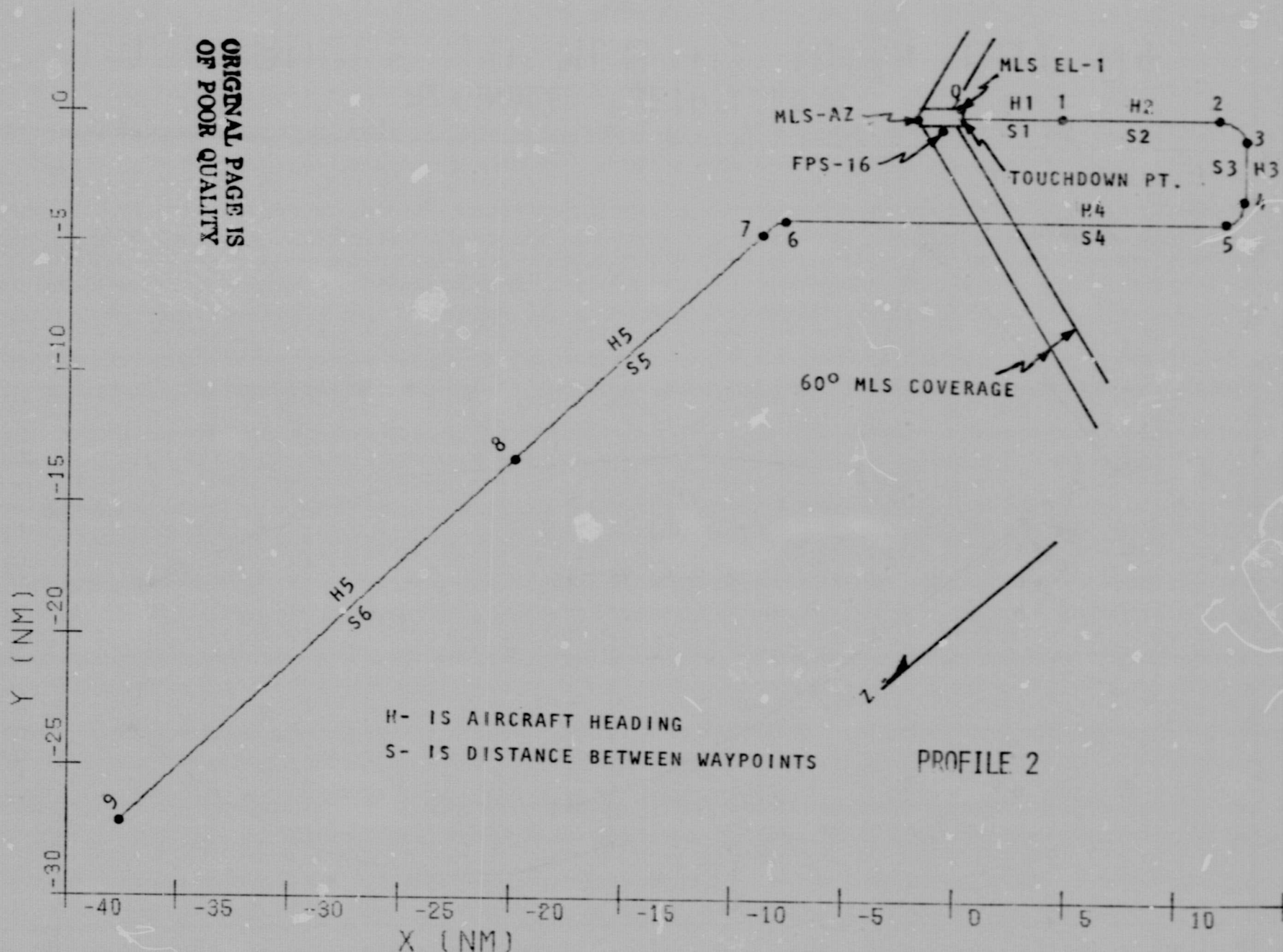
FIGURE 3B



LOOK ANGLE TO FPS-16 RADAR RWY 04

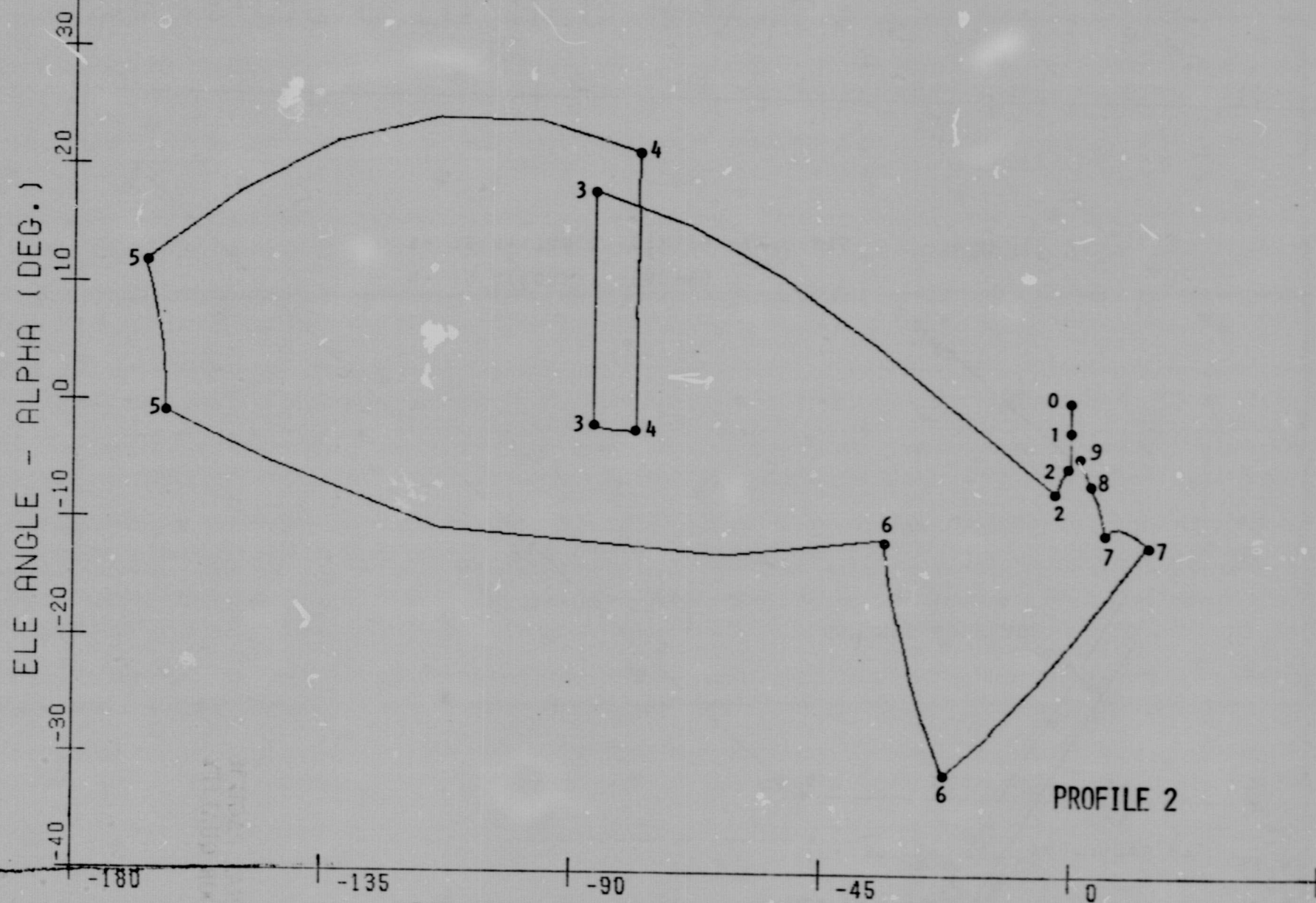
FIGURE 3c

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APPROACH TO WFC RWY 04

FIGURE 4



LOOK ANGLE TO MLS AZ ANT. RWY 04

FIGURE 4A

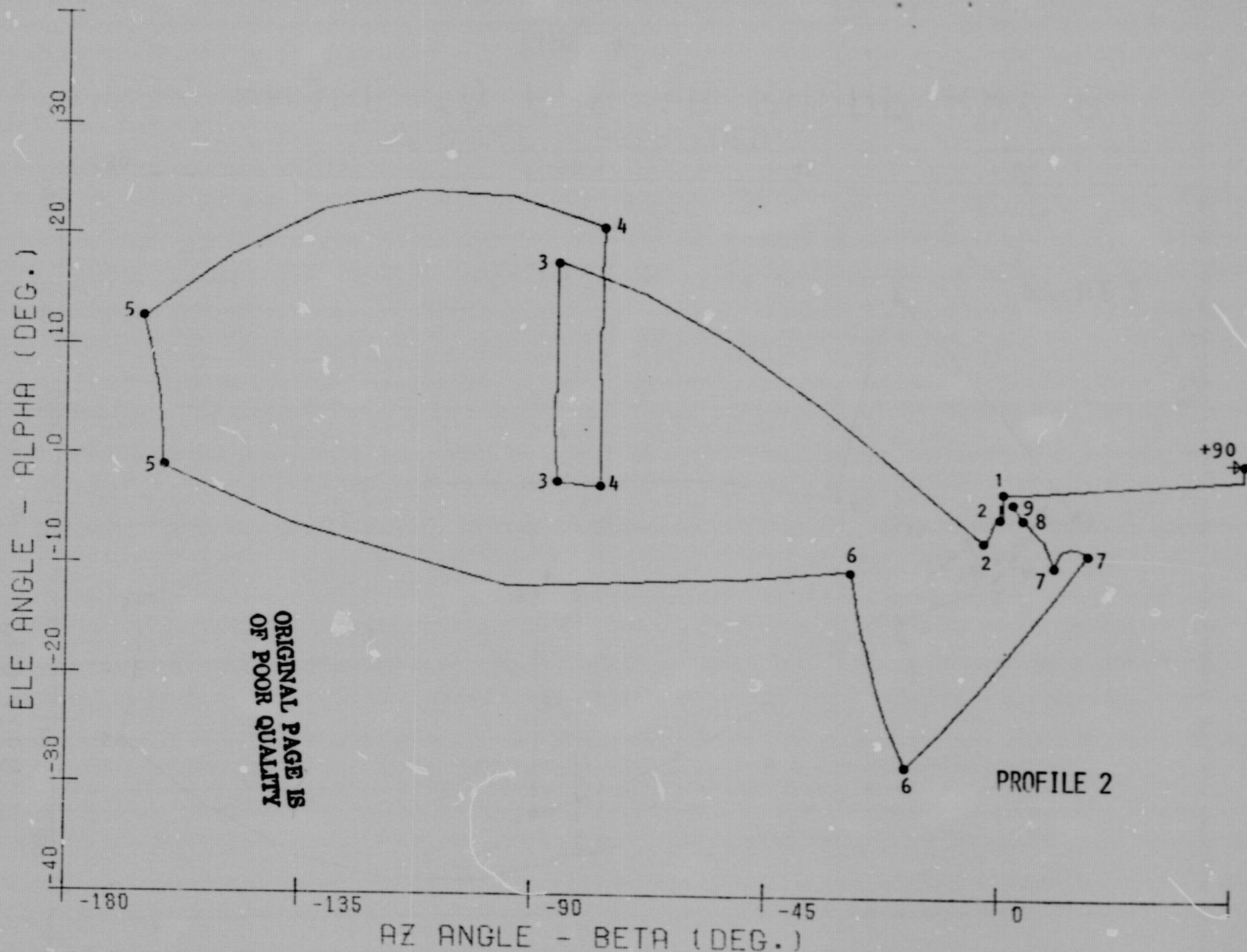
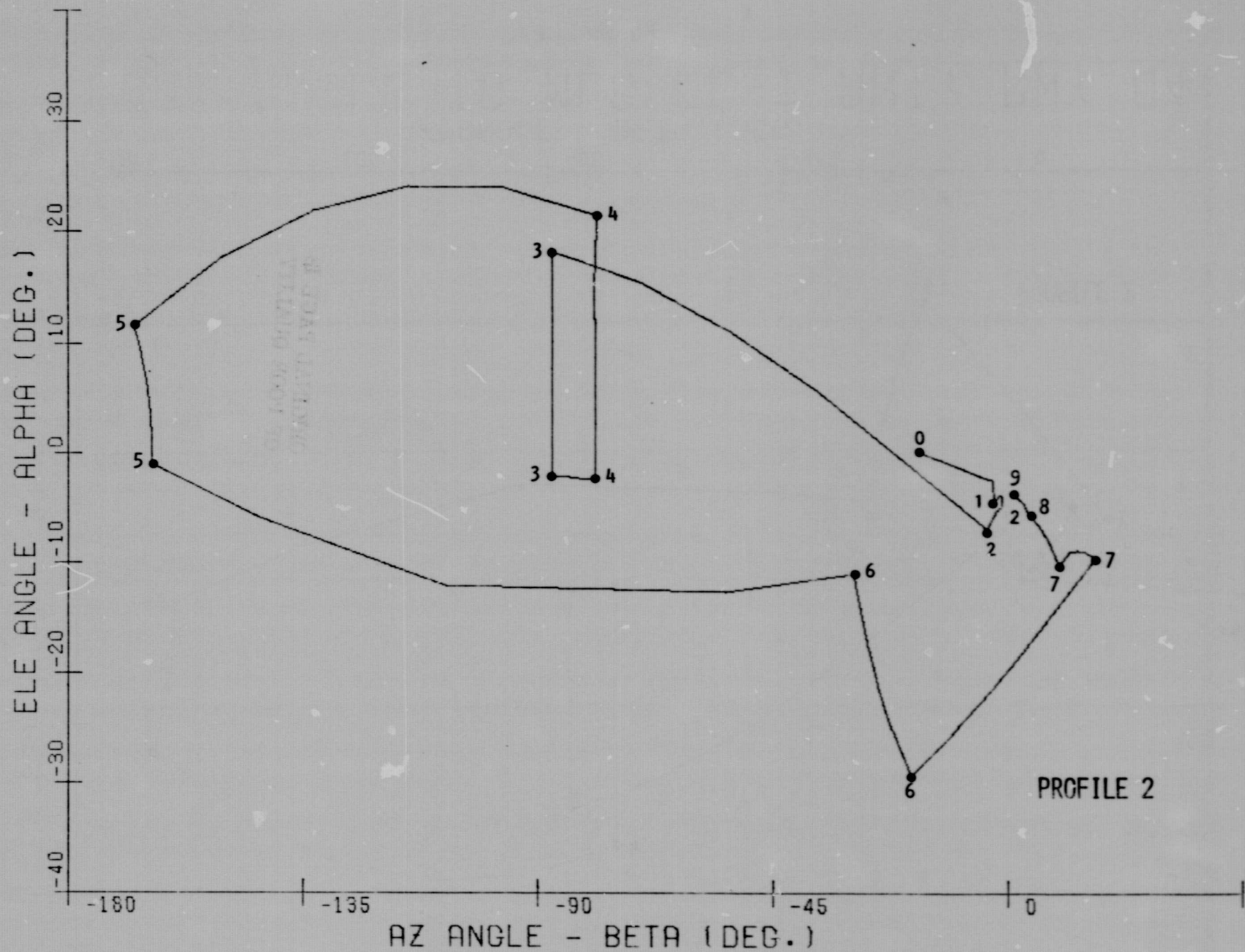
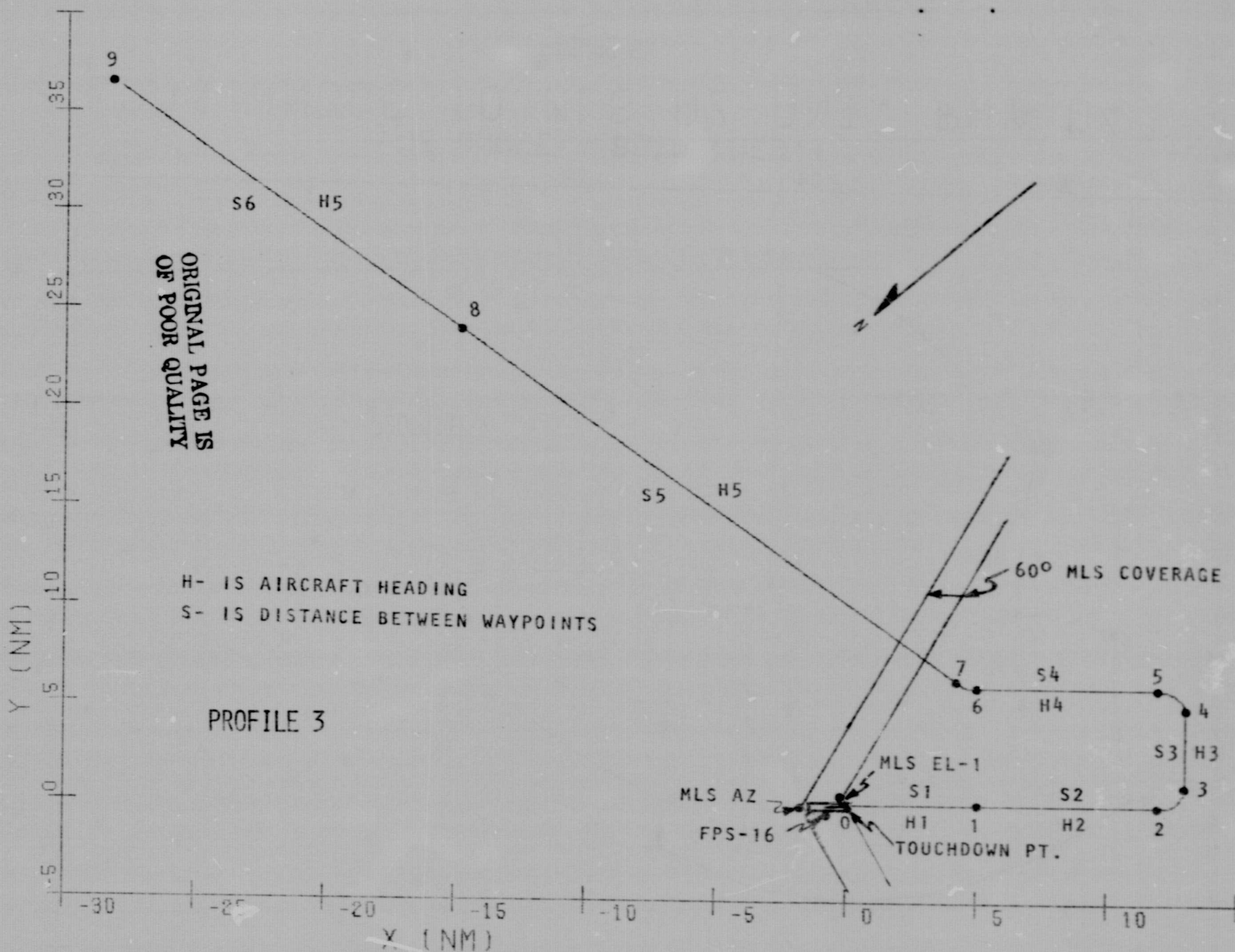


FIGURE 4B



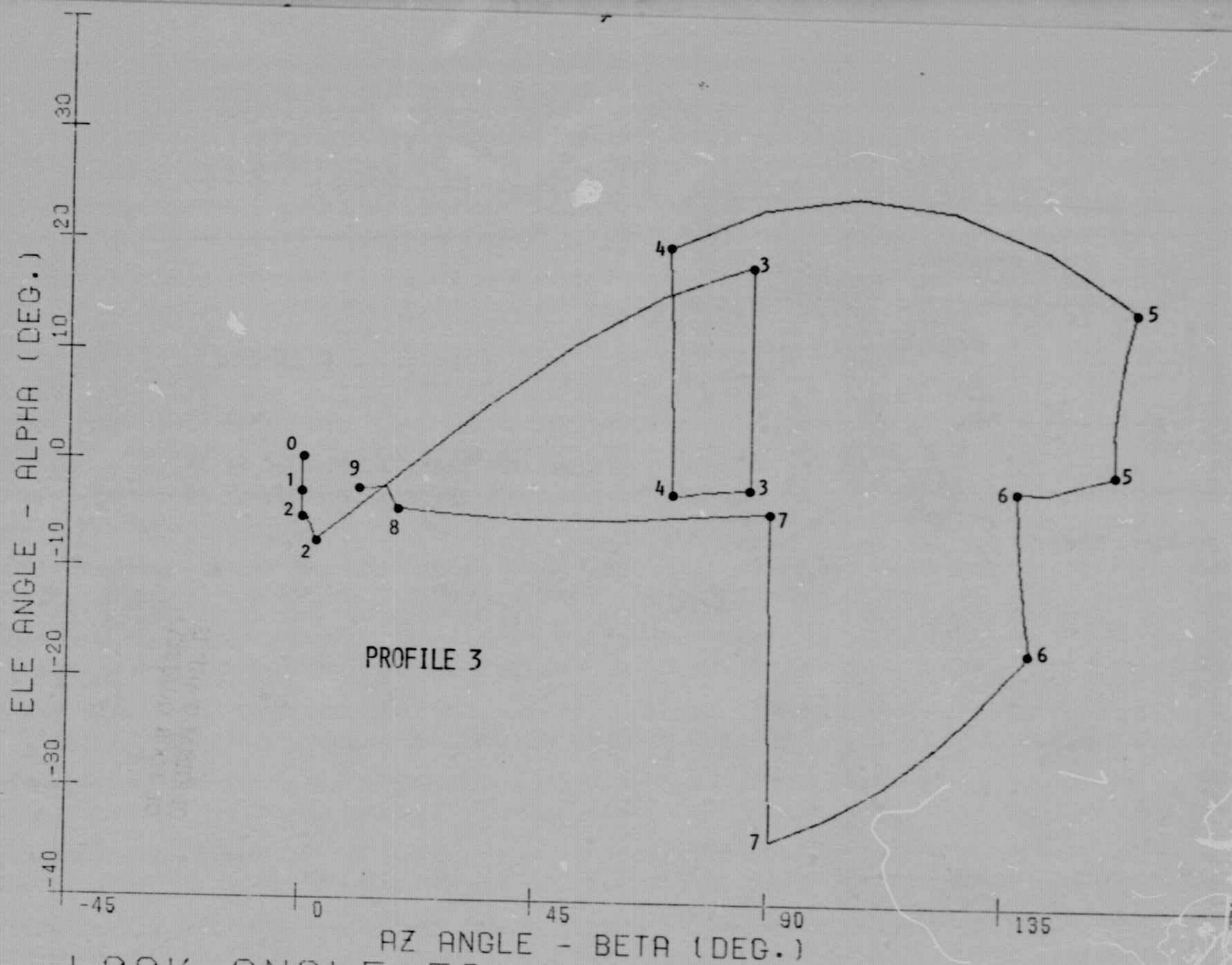
LOOK ANGLE TO FPS-16 RADAR RWY 04

FIGURE 4c



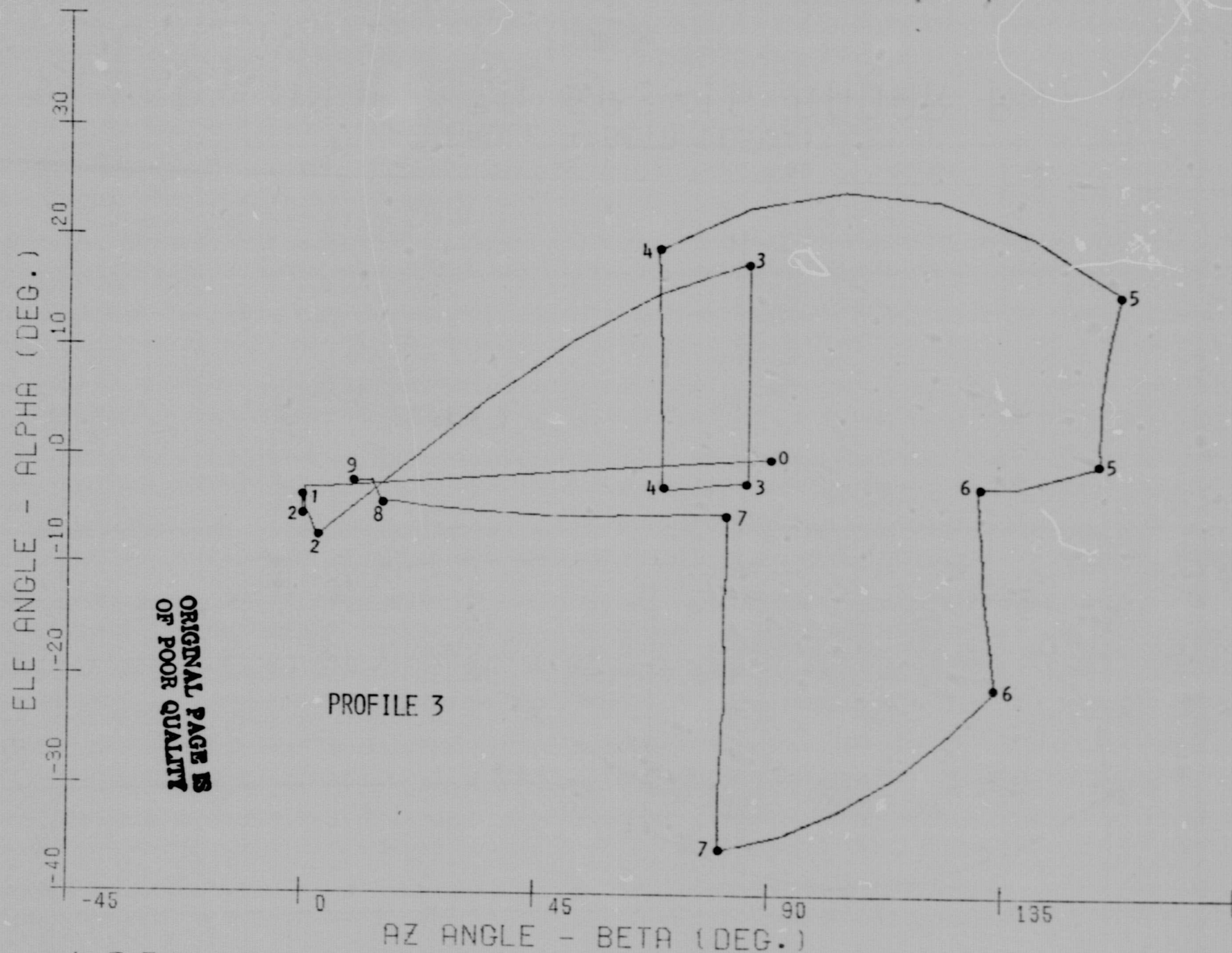
APPROACH TO WFC RWY 04

FIGURE 5



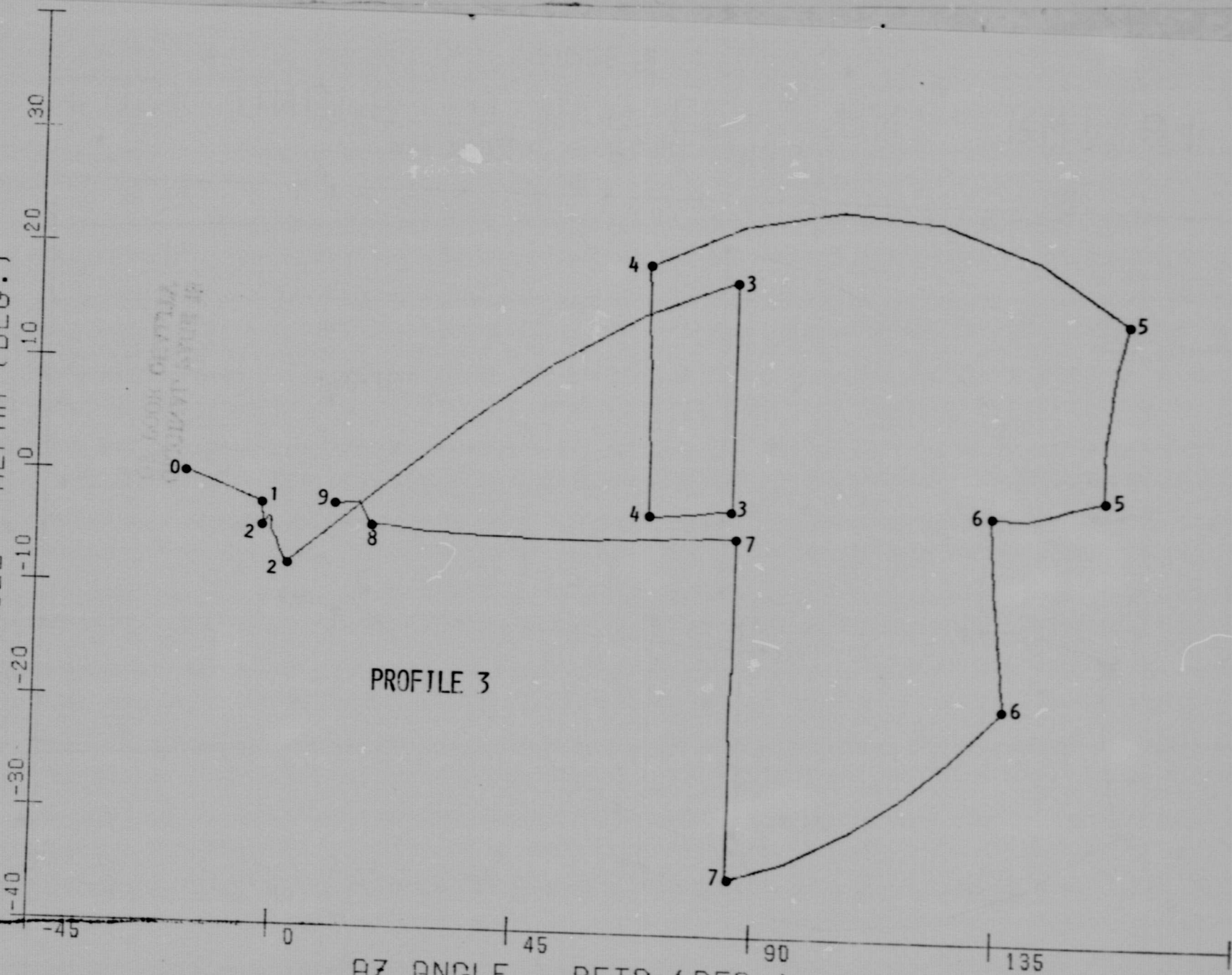
LOOK ANGLE TO MLS AZ ANT. RWY 04

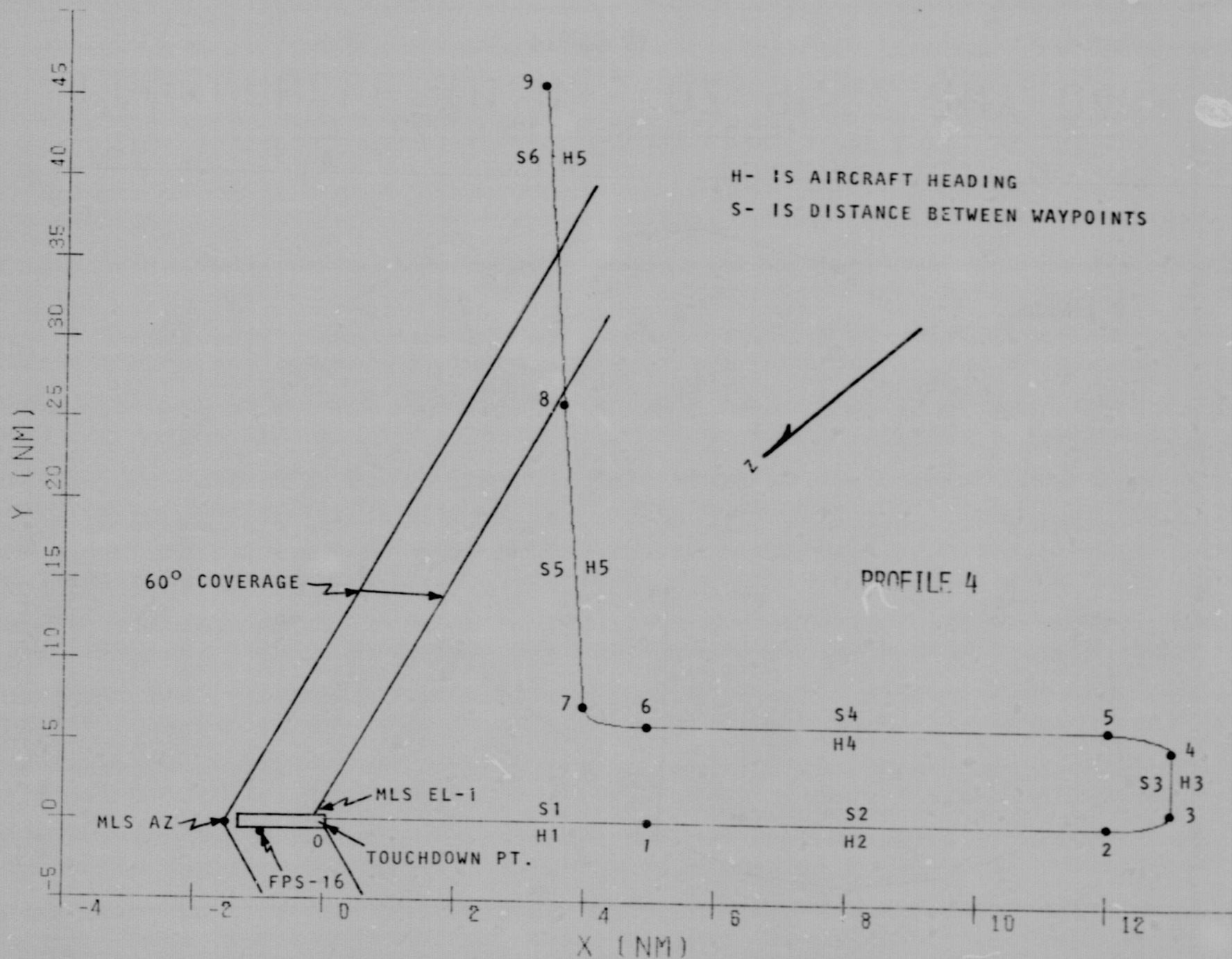
FIGURE 5A



LOOK ANGLE TO MLS EL-1 ANT. RWY 04

FIGURE 5B





APPROACH TO WFC RUNWAY 04

FIGURE 6

OF 1000 GALS
CURRENT 5000 10

ELE ANGLE - ALPHA (DEG.)

30
20
10
0
-10
-20
-30
-40

-45

0

45

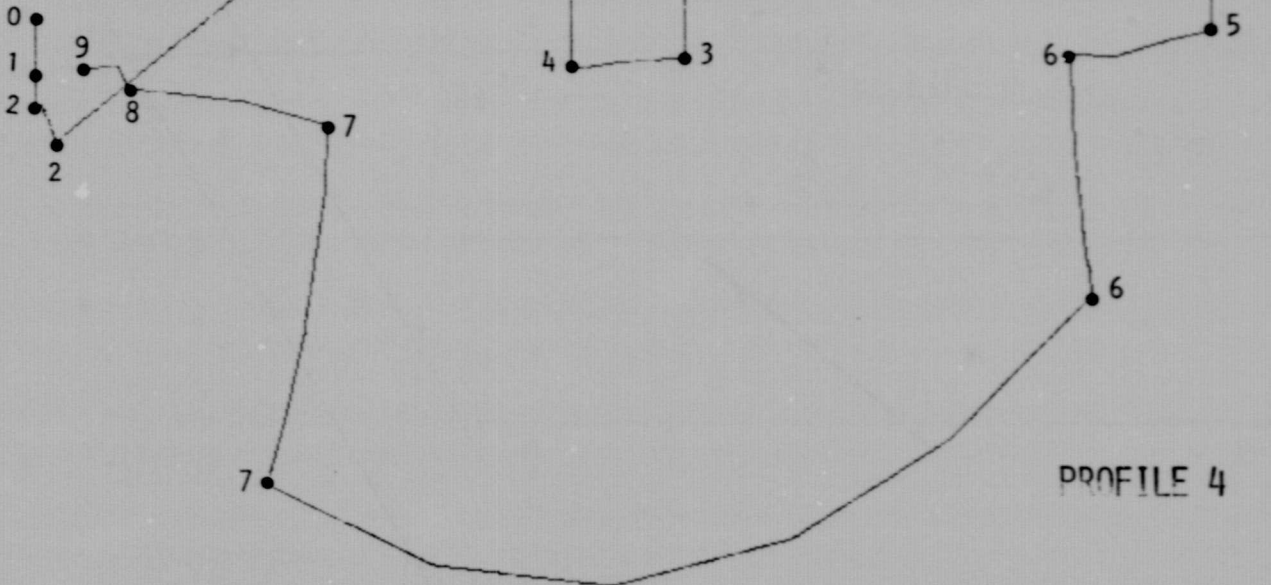
90

135

AZ ANGLE - BETA (DEG.)

LOOK ANGLE TO MLS AZ ANT. RWY 04

FIGURE 6A



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ELE ANGLE - ALPHA (DEG.)

30
20
10
0
-10
-20
-30
-40

45

0

45

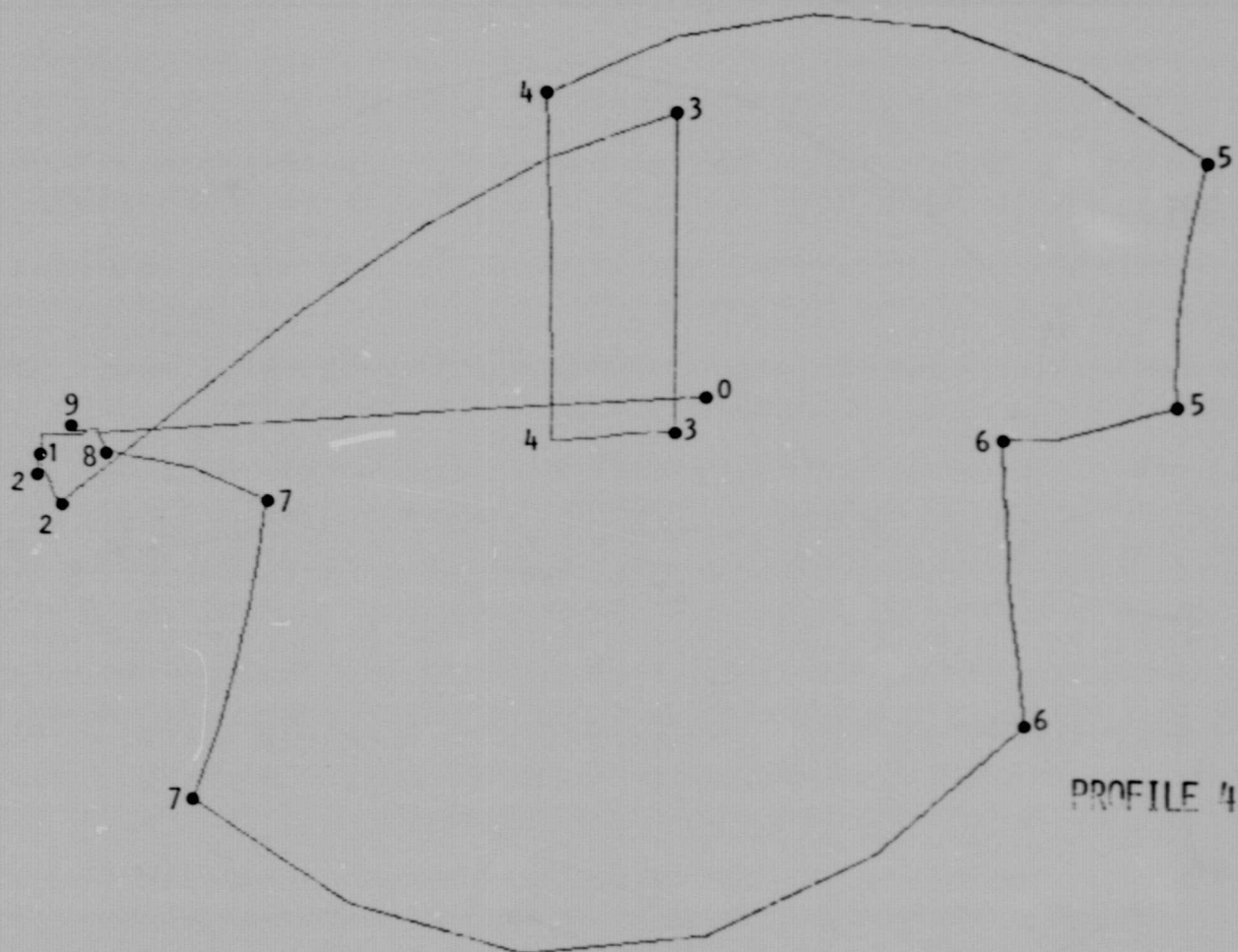
90

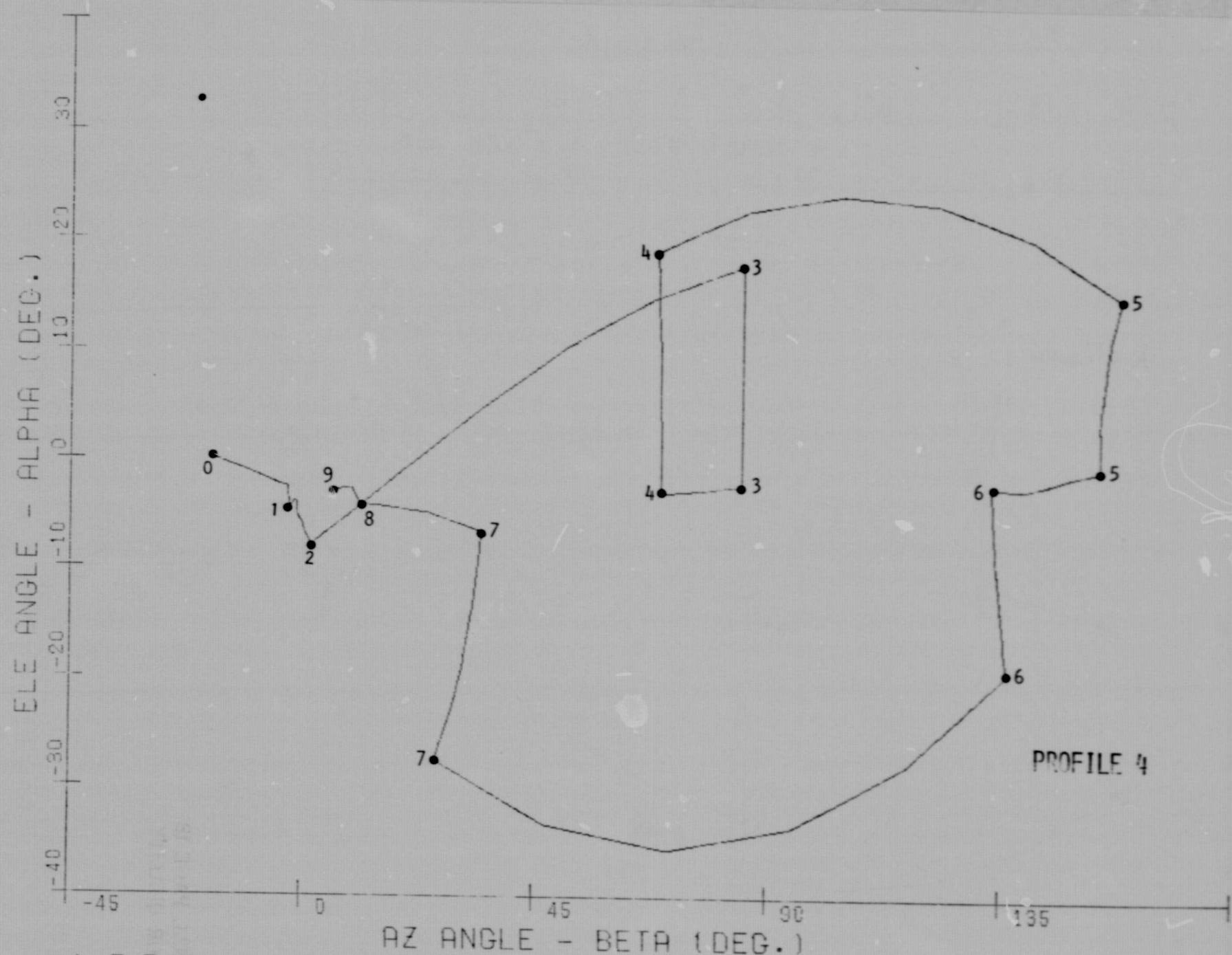
135

AZ ANGLE - BETA (DEG.)

LOOK ANGLE TO MLS EL-1 ANT. RWY 04

FIGURE 6B





LOOK ANGLE TO FPS-16 RADAR RWY 04

FIGURE 6c

READY

APPENDIX A

```
12 PRINT "J4=0 FOR MLS OR TO PLOT PATH; NON-0 FOR FPS-16";
14 INPUT J4
16 IF J4=0 THEN 20
17 PRINT "INPUT J5,J6 AS PER FINAL HEADING (H1)";
18 INPUT J5,J6
20 DIM A(32)
21 MAT A=ZER
22 LET L4=1
24 LET M=0
26 LET N4=1
30 DIM I(32)
31 MAT I=ZER
32 LET L5=20
34 LET M5=0
36 LET N5=1
80 PRINT "J7=0 TO PLOT PATH; NON-0 FOR LOOK ANGLES";
82 INPUT J7
84 READ H1,H3,H4
86 DATA 40,210,220
88 READ H5
90 DATA 263
92 READ S1
94 DATA 5
96 READ S2
98 DATA 7
100 READ S3
110 DATA 4
120 READ S4
130 DATA 7
140 READ S5
150 DATA 26
160 READ S6
170 DATA 18
172 READ V0,Z0
174 DATA 130,0
180 READ V1,Z1
190 DATA 130,1750
200 READ V2,Z2
210 DATA 160,2750
220 READ V3,Z3
230 DATA 160,2750
240 READ V4,Z4
250 DATA 180,2750
260 READ V5,Z5
270 DATA 180,2750
280 READ V6,Z6
290 DATA 200,3750
300 READ V7,Z7
310 DATA 200,3750
```

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```

320 READ V8,Z8
330 DATA 250.6750
340 READ V9,Z9
350 DATA 350.12750
360 READ C,J,J1,J2
370 DATA 1.74533E-02,5.5,6076.1
380 READ U
390 DATA 60
400 READ R
410 DATA 1
414 PRINT "J8=0 TO PRINT ALL DATA & PLOT LOOK ANGLES:"
415 PRINT "NON-0 FOR PLOT ONLY (LOOK ANGLES OR PATH)":
416 INPUT J8
420 READ X0,Y0
430 DATA 0.0
500 LET X1=S1
510 LET Y1=0
520 LET X2=S1+S2
530 LET Y2=0
540 LET X3=X2+R
550 LET Y3=SGN(U)*R
560 LET X4=X3
570 LET Y4=Y3+SGN(U)*S3
580 LET X5=X2
590 LET Y5=Y4+SGN(U)*R
600 LET X6=X5-S4
610 LET Y6=Y5
620 LET E=H5-H4
625 GOSUB 5700
630 LET X7=X6-SGN(U)*R1*SIN(E*C)
640 LET Y7=Y6+SGN(U)*R1*(1-COS(E*C))
650 IF ABS(E)>180 THEN 670
660 GOTO 680
670 LET E=360-ABS(E)
680 LET X8=X7-S5*COS(ABS(E)*C)
690 LET Y8=Y7+SGN(U)*S5*SIN(ABS(E)*C)
700 LET X9=X8-S6*COS(ABS(E)*C)
710 LET Y9=Y8+SGN(U)*S6*SIN(ABS(E)*C)
711 IF J7=0 THEN 720
712 IF J8#0 THEN 850
715 CALL (8,1)
717 PRINT "

```

```

720 PRINT "X0="X0;"Y0="Y0;"Z0="Z0;"V0="V0
721 PRINT
722 PRINT "X1="X1;"Y1="Y1;"Z1="Z1;"V1="V1
723 PRINT
724 PRINT "X2="X2;"Y2="Y2;"Z2="Z2;"V2="V2
725 PRINT
726 PRINT "X3="X3;"Y3="Y3;"Z3="Z3;"V3="V3
727 PRINT
728 PRINT "X4="X4;"Y4="Y4;"Z4="Z4;"V4="V4
729 PRINT
730 PRINT "X5="X5;"Y5="Y5;"Z5="Z5;"V5="V5
731 PRINT
732 PRINT "X6="X6;"Y6="Y6;"Z6="Z6;"V6="V6
733 PRINT
734 PRINT "X7="X7;"Y7="Y7;"Z7="Z7;"V7="V7
735 PRINT
736 PRINT "X8="X8;"Y8="Y8;"Z8="Z8;"V8="V8
737 PRINT
738 PRINT "X9="X9;"Y9="Y9;"Z9="Z9;"V9="V9
739 PRINT
745 PRINT "H1="H1;"H3="H3;"H4="H4;"H5="H5
750 PRINT
755 PRINT "S1="S1;"S2="S2;"S3="S3;"S4="S4
760 PRINT
850 LET H=H5
860 LET B=0
862 LET S8=R1*C*ABS(E)
864 LET S9=R1*C*90
866 LET S=S1+S2+S3+S3+S3+S4+S5+S5+S6
870 LET L=(X9-X8)/J
880 LET M=(Y9-Y8)/J
890 LET N=(Z9-Z8)/J
900 LET Q=(V9-V8)/J
910 LET K=S6/J
920 LET X=X9
930 LET Y=Y9
940 LET Z=Z9
950 LET V=V9
960 LET G=ATN((Z9-Z8)/(S6*J2))/C
962 IF J0#0 THEN 970
965 PRINT "S5="S5;"S6="S6;"S8="S8;"S9="S9
970 GOSUB 6800
1110 GOSUB 4500
1120 IF S>S1+S2+S3+S3+S3+S4+S5+S5+K/2 THEN 970
1130 LET L=(X8-X7)/J
1140 LET M=(Y8-Y7)/J
1150 LET N=(Z8-Z7)/J
1160 LET Q=(V8-V7)/J
1170 LET K=S5/J
1172 LET G=ATN((Z8-Z7)/(S5*J2))/C
1180 GOSUB 6800
1330 GOSUB 4500
1340 IF S>S1+S2+S3+S3+S3+S4+S5+S5+K/2 THEN 1180

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1350 LET E6=ABS(E)
1360 LET W=E6/J1
1362 LET G=0
1364 LET K=S8/J1
1370 LET B5=-SGN(U)*ATN((1.688+2*V7+2)/(32.2*R1*J2))/C
1375 GOSUB 6800
1450 GOSUB 4800
1460 GOSUB 6800
1480 LET E6=E6-W
1490 LET H=H-SGN(U)*W
1500 IF H>360 THEN 1520
1510 GOTO 1530
1520 LET H=H-360
1530 IF H<0 THEN 1550
1540 GOTO 1560
1550 LET H=360+H
1560 LET X=X6-R1*SIN(E6*C)
1570 LET Y=Y6+SGN(U)*R1*(1-COS(E6*C))
1580 LET S=S-K
1590 IF S>S1+S2+S9+S3+S9+S4+K/2 THEN 1460
1600 GOSUB 6800
1690 GOSUB 6600
1710 LET L=(X6-X5)/J
1720 LET M=(Y6-Y5)/J
1730 LET N=(Z6-Z5)/J
1740 LET Q=(V6-V5)/J
1750 LET K=S4/J
1760 LET G=ATN((Z6-Z5)/(S4*J2))/C
1770 GOSUB 4500
1870 GOSUB 6800
1880 IF S>S1+S2+S9+S3+S9+K/2 THEN 1770
1890 LET E1=0
1900 LET W=90/J1
1905 LET K=S9/J1
2010 LET G=0
2011 LET B5=SGN(U)*ATN((1.688+2*V7+2)/(32.2*R*J2))/C
2012 GOSUB 6800
2015 GOSUB 4800
2020 GOSUB 6800
2025 LET E1=E1+W
2030 LET H=H+SGN(U)*W
2040 IF H>360 THEN 2060
2050 GOTO 2070
2060 LET H=H-360
2070 IF H<0 THEN 2090
2080 GOTO 2100
2090 LET H=360+H
2100 LET X=X5+R*SIN(E1*C)
2110 LET Y=Y4+SGN(U)*R*COS(E1*C)
2120 LET S=S-K
2130 IF S>S1+S2+S9+S3+K/2 THEN 2020
2140 GOSUB 6800
2250 GOSUB 6600
2260 LET L=(W4-X3)/J

```

```

2270 LET M=(Y4-Y3)/J
2280 LET N=(Z4-Z3)/J
2290 LET Q=(V4-V3)/J
2300 LET K=S3/J
2310 LET G=ATN((Z4-Z3)/(S3*J2))/C
2320 GOSUB 4500
2420 GOSUB 6800
2430 IF S>S1+S2+S9+K/2 THEN 2320
2440 LET E1=90
2450 LET W=E1/J1
2455 LET K=S9/J1
2560 LET G=0
2570 LET B5=SGN(U)*ATN((1.688+2*V+2)/(32.2*R*J2))/C
2575 GOSUB 4800
2577 GOSUB 6800
2580 LET E1=E1-W
2590 LET H=H+SGN(U)*W
2600 IF H>360 THEN 2620
2610 GOTO 2630
2620 LET H=H-360
2630 IF H<0 THEN 2650
2640 GOTO 2660
2650 LET H=360+H
2660 LET X=X2+R*SIN(E1*C)
2670 LET Y=Y3-SGN(U)*R*COS(E1*C)
2680 LET S=S-K
2690 IF S>S1+S2+K/2 THEN 2577
2700 GOSUB 6800
2800 GOSUB 6600
2810 LET L=(X2-X1)/J
2820 LET M=(Y2-Y1)/J
2830 LET N=(Z2-Z1)/J
2840 LET Q=(V2-V1)/J
2850 LET K=S2/J
2860 LET G=ATN((Z2-Z1)/(S2*J2))/C
2870 GOSUB 4500
2900 GOSUB 6800
2990 IF S>S1+K/2 THEN 2870
3000 LET L=X1/J
3010 LET M=Y1/J
3020 LET N=(Z1-Z0)/J
3030 LET K=S1/J
3035 LET Q=(V1-V0)/J
3040 LET G=ATN((Z1-Z0)/(S1*J2))/C
3050 GOSUB 4500
3200 GOSUB 6800
3210 IF S>K/2 THEN 3050
3215 LET G=0
3360 CALL (3,AC11,1,L4)
3365 CALL (3,IC11,1,L5)
3370 PRINT "L4="L4
3375 PRINT "L5="L5
3380 PRINT "M4="M4
3381 PRINT "M5="M5

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3390 CALL (8,8)
3400 GOTO 9999
4500 LET X=X-L
4510 LET Y=Y-M
4520 LET Z=Z-N
4530 LET V=V-Q
4540 LET S=S-K
4550 RETURN
4700 PRINT
4701 PRINT
4705 PRINT "X="X;"Y="Y;"Z="Z
4710 PRINT
4720 PRINT "HEADING="H;"BANK="B;"GS="G;"DTG="S;"V="V
4740 RETURN
4800 LET B=B5/J1
4810 GOSUB 6800
4890 LET B=B+B5/J1
4900 IF ABS(B)<ABS(B5)-ABS(B5)/(2*J1) THEN 4910
4910 RETURN
5000 LET B=-C*B
5001 LET X=X*J2
5002 LET Y=Y*J2
5003 LET H=C*(H-H1)
5004 GOSUB 5500
5006 LET X=X+9000
5008 GOSUB 5030
5009 IF J8#0 THEN 5014
5010 PRINT "TO AZ SITE:";
5012 GOSUB 5210
5014 GOSUB 5300
5016 LET X=X-9000
5020 LET Y=Y-300
5022 GOSUB 5030
5023 IF J8#0 THEN 5027
5024 PRINT "TO EL-1 SITE:";
5025 GOSUB 5210
5027 GOSUB 5400
5028 LET Y=Y+300
5029 GOTO 5100
5030 LET P9=X*COS(P)*COS(H)-Y*COS(P)*SIN(H)+Z*SIN(P)
5040 LET Q9=X*(SIN(B)*SIN(P)*COS(H)-COS(B)*SIN(H))
5050 LET Q9=Q9-Y*(SIN(B)*SIN(P)*SIN(H)+COS(B)*COS(H))
5060 LET Q9=Q9-Z*SIN(B)*COS(P)
5070 LET R9=X*(COS(B)*SIN(P)*COS(H)+SIN(B)*SIN(H))
5080 LET R9=R9-Y*(COS(B)*SIN(P)*SIN(H)-SIN(B)*COS(H))
5090 LET R9=R9-Z*COS(B)*COS(P)
5100 LET A9=ATN(R9/SQR(P9*P9+Q9*Q9))*57.2958
5110 IF P9#0 THEN 5130
5120 LET P9=.1
5122 PRINT "X=.1"
5130 LET B9=ATN(Q9/P9)*57.2958
5140 IF P9>0 THEN 5160
5150 LET B9=SGN(Q9)*180+B9

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5160 RETURN
5180 LET P=-P/C
5190 LET B=-B/C
5200 LET H=H1+H/C
5202 LET X=X/J2
5203 LET Y=Y/J2
5205 RETURN
5210 PRINT "ALPHA ="A9;"BETA ="B9;"PITCH ="P
5230 RETURN
5300 LET ACN4J=B9
5310 LET ACN4+1J=A9
5320 LET M4=M4+1
5340 LET N4=N4+2
5350 IF N4>32 THEN 5365
5360 RETURN
5365 CALL (3,AC1J,1,L4)
5370 LET N4=1
5380 LET L4=L4+1
5385 MAT A=ZER
5390 RETURN
5400 LET ICN5J=B9
5405 LET ICN5+1J=A9
5410 LET M5=M5+1
5415 LET N5=N5+2
5420 IF N5>32 THEN 5430
5425 RETURN
5430 CALL (3,IC1J,1,L5)
5435 LET N5=1
5440 LET L5=L5+1
5445 MAT I=ZER
5450 RETURN
5455 LET ACN4J=X
5458 LET ACN4+1J=Y
5460 LET M4=M4+1
5462 LET N4=N4+2
5464 IF N4>32 THEN 5468
5466 RETURN
5468 CALL (3,AC1J,1,L4)
5470 LET N4=1
5472 LET L4=L4+1
5474 MAT A=ZER
5476 RETURN
5500 LET P=3-G
5510 LET P=P+42*(SOR(1+TAN(B)*2)-1)
5520 LET P=-C*P
5530 RETURN
5700 LET B=ATN((1.688*2*V7*2)/(32.2*R*J2))/C
5705 IF B>30 THEN 5720
5707 LET R1=1
5710 RETURN
5720 LET R1=(1.688*2*V7*2)/(32.2*J2*TAN(33*C))
5730 RETURN
6000 LET X=X*J2
6002 LET Y=Y*J2

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6005 LET D=SQR(X^2+(Y-300)^2+Z^2)
6010 LET T=8.68589*LOG(66.42*D)
6020 LET F=(ATN((Y-300)/X))/C
6022 IF X>0 THEN 6030
6025 LET F=SGN(U)*(180-ABS(F))
6030 LET F2=SQR(X^2+(Y-300)^2)
6040 LET E8=(ATN(Z/F2))/C
6045 IF ABS(F)>ABS(U) THEN 6054
6050 PRINT "INSIDE MLS COVERAGE ZONE"
6052 GOTO 6055
6054 PRINT "OUTSIDE MLS COVERAGE ZONE"
6055 PRINT "FROM EL1 SITE:":
6060 PRINT "AZ="F;"EL="E8;"RANGE="D/6076.1;"LOSS="T
6070 LET D1=SQR((X+9000)^2+Y^2+Z^2)
6080 LET T1=8.68589*LOG(66.42*D1)
6090 LET F1=(ATN(Y/(X+9000)))/C
6092 IF X>-9000 THEN 6100
6095 LET F1=SGN(U)*(180-ABS(F1))
6100 LET F3=SQR((X+9000)^2+Y^2)
6110 LET E2=(ATN(Z/F3))/C
6120 PRINT "FROM AZ SITE:":
6130 PRINT "AZ="F1;"EL="E2;"RANGE="D1/6076.1;"LOSS="T1
6140 LET X=X/J2
6150 LET Y=Y/J2
6500 RETURN
6600 LET B=B-B5/J1
6605 GOSUB 6800
6690 IF ABS(B)>ABS(B5)/(2*J1) THEN 6600
6700 RETURN
6800 IF J7#0 THEN 6806
6802 GOSUB 5455
6804 RETURN
6806 IF J8#0 THEN 6810
6808 GOSUB 4700
6810 IF J4#0 THEN 6050
6820 GOSUB 5000
6825 IF J9#0 THEN 6880
6830 GOSUB 6000
6840 GOTO 6880
6850 GOSUB 7000
6855 IF J8#0 THEN 6880
6860 GOSUB 8000
6870 GOSUB 9000
6880 RETURN
7000 LET B=-C*B
7010 LET H=C*(H-H1)
7012 LET X=X*J2
7014 LET Y=Y*J2
7020 GOSUB 5500
7030 LET Y=Y-J5
7040 LET X=X-J6
7050 GOSUB 5030
7055 IF J8#0 THEN 7075
7060 PRINT "TO FPS-16 SITE"

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7070 GOSUB 5210
7075 GOSUB 5300
7080 LET Y=Y+J5
7090 LET X=X+J6
7110 GOTO 5180
7120 RETURN
8000 LET X=X*J2
8002 LET Y=Y*J2
8005 LET D=SQR((X-J6)+2+(Y-J5)+2+Z+2)
8010 LET T=8.68589*LOG(66.42*D)
8020 LET F=ATN((Y-J5)/(X-J6))/C
8022 IF X>J6 THEN 8030
8025 LET F=SGN(U)*(180-ABS(F))
8030 LET F2=SQR((X-J6)+2+(Y-J5)+2)
8040 LET E8=ATN(Z/F2)/C
8060 PRINT "FROM FPS-16 SITE"
8070 PRINT "AZ="F;"EL="E8;"RANGE="D/6076.1;"LOSS="T
8087 LET X=X/J2
8088 LET Y=Y/J2
8090 RETURN
9000 LET X=X*J2
9010 LET Y=Y*J2
9020 LET F3=(ATN((Y-300)/X))/C
9030 IF X>0 THEN 9040
9035 LET F3=SGN(U)*(180-ABS(F3))
9040 IF ABS(F3) <= ABS(U) THEN 9090
9050 PRINT "OUTSIDE MLS COVERAGE ZONE"
9060 LET X=X/J2
9070 LET Y=Y/J2
9080 RETURN
9090 PRINT "INSIDE MLS COVERAGE ZONE"
9100 GOTO 9060
9999 END

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READY

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